Low Noise Amplifier
0.5 - 1.6 GHz

Features
- Low Noise Figure
- Excellent Input Return Loss
- Single Voltage Bias 3 V
- Integrated Active Bias Circuit
- Current Adjustable 20 - 80 mA with an External Resistor
- High Linearity, OIP3 >32 dBm
- Small Package: 2 mm PDFN-8LD
- RoHS* Compliant

Description
The MAAL-010705 is a high dynamic range single stage MMIC LNA with excellent linearity and low noise figure designed for operation from 0.5 to 1.6 GHz. The LNA is packaged in an RoHS compliant leadless 2 mm 8-lead PDFN package.

This MMIC has an integrated active bias circuit allowing direct connection to 3 V voltage supply and minimizing variation over temperature and process. The bias current and gain can be set with external resistors to allow the user to customize the current and gain value to fit the application.

The MAAL-010705 offers less than 0.7 dB noise figure, more than 32 dBm OIP3 and 20 dB input return loss. The excellent input match, low noise figure and high OIP3 along with the flexibility of setting current and gain make this LNA ideal for 3G and 4G cellular infrastructure applications.

For optimum performance above 1.6 GHz the MAAL-010706 is recommended. The MAAL-010705 and MAAL-010706 share the package type and footprint.

Functional Block Diagram

Pin Configuration
<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Pin Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N/C</td>
<td>No Connection</td>
</tr>
<tr>
<td>2</td>
<td>RF_IN</td>
<td>RF Input</td>
</tr>
<tr>
<td>3</td>
<td>RF GND</td>
<td>RF Ground</td>
</tr>
<tr>
<td>4</td>
<td>V_BIAS</td>
<td>Bias Voltage</td>
</tr>
<tr>
<td>5</td>
<td>FB</td>
<td>Feedback</td>
</tr>
<tr>
<td>6</td>
<td>N/C</td>
<td>No Connection</td>
</tr>
<tr>
<td>7</td>
<td>RF_OUT</td>
<td>RF Output</td>
</tr>
<tr>
<td>8</td>
<td>N/C</td>
<td>No Connection</td>
</tr>
</tbody>
</table>

Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAAL-010705-TR3000</td>
<td>tape and reel</td>
</tr>
<tr>
<td>MAAL-010705-001SMB</td>
<td>evaluation board</td>
</tr>
</tbody>
</table>

1. Reference Application Note M513 for reel size information.
2. All sample boards include 5 loose parts.

**Low Noise Amplifier**
0.5 - 1.6 GHz

**Electrical Specifications**
Freq = 0.9 GHz, $V_D = 4$ V, $T_A = +25^\circ$C, $Z_0 = 50$ $\Omega$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Units</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain</td>
<td>—</td>
<td>dB</td>
<td>18</td>
<td>21</td>
<td>—</td>
</tr>
<tr>
<td>Output IP3</td>
<td>$P_{OUT} = 5$ dBm, Tone Spacing = 1 MHz</td>
<td>dBm</td>
<td>—</td>
<td>32</td>
<td>—</td>
</tr>
<tr>
<td>Output P1dB</td>
<td>—</td>
<td>dBm</td>
<td>17.5</td>
<td>18.5</td>
<td>—</td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>—</td>
<td>dB</td>
<td>—</td>
<td>19</td>
<td>—</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td></td>
<td>dB</td>
<td>—</td>
<td>18</td>
<td>—</td>
</tr>
<tr>
<td>Noise Figure</td>
<td>—</td>
<td>dB</td>
<td>—</td>
<td>0.50</td>
<td>—</td>
</tr>
<tr>
<td>Total Current</td>
<td>$I_{DO} = I_D + I_{BIAS}$</td>
<td>mA</td>
<td>—</td>
<td>60</td>
<td>70</td>
</tr>
</tbody>
</table>

3. $V_D$ and $V_{BIAS}$ are connected together to $+4$ V, $R_3 = 150$ $\Omega$ and $R_4 = 240$ $\Omega$, reference recommended schematic on page 8.

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>5.5 V</td>
</tr>
<tr>
<td>Current</td>
<td>100 mA</td>
</tr>
<tr>
<td>Power Dissipation</td>
<td>600 mW</td>
</tr>
<tr>
<td>RF Input Power</td>
<td>20 dBm</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-55ºC to +150ºC</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-40ºC to +85ºC</td>
</tr>
<tr>
<td>Junction Temperature$^6$</td>
<td>+150ºC</td>
</tr>
</tbody>
</table>

4. Exceeding any one or combination of these limits may cause permanent damage to this device.
5. MACOM does not recommend sustained operation near these survivability limits.
6. Typical thermal resistance ($\Theta_{jc}$) = 45ºC/W.

**Handling Procedures**

Please observe the following precautions to avoid damage:

**Static Sensitivity**

Gallium Arsenide Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these class 1A devices.
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Typical Performance Curves: 4 V (over current)

Input Return Loss

Output Return Loss

Gain

Noise Figure

OIP3

P1dB

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Typical Performance Curves: 4 V (over R3)

**Gain**

- **NF (dB)** vs **Pout (dBm)**
- **Fmin (dB)** vs **R3 (Ohm)**

**Noise Figure & Fmin**

- **NF (dB)**
- **Fmin (dB)**

**OIP3**

- **OIP3 (dBm)** vs **Pout (dBm)**

**P1dB**

- **P1dB (dBm)** vs **R3 (Ohm)**

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Typical Performance Curves: 4 V (over temperature)

**Input Return Loss**

**Output Return Loss**

**Gain**

**Noise Figure**

**OIP3**

**P1dB**
Typical Performance Curves: 3 V

**Input Return Loss**

- $I_d (mA) = 20$
- $I_d (mA) = 40$
- $I_d (mA) = 60$
- $I_d (mA) = 80$

**Output Return Loss**

- $I_d (mA) = 20$
- $I_d (mA) = 40$
- $I_d (mA) = 60$
- $I_d (mA) = 80$

**Gain**

- $I_d (mA) = 20$
- $I_d (mA) = 40$
- $I_d (mA) = 60$
- $I_d (mA) = 80$

**Noise Figure**

- $I_d (mA) = 20$
- $I_d (mA) = 40$
- $I_d (mA) = 60$
- $I_d (mA) = 80$

**OIP3**

- $I_d (mA) = 20$
- $I_d (mA) = 40$
- $I_d (mA) = 60$
- $I_d (mA) = 80$

**P1dB**

- $I_d (mA) = 20$
- $I_d (mA) = 40$
- $I_d (mA) = 60$
- $I_d (mA) = 80$
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S-Parameters\(^7\): 4 V

Reverse Isolation

Gain

Output Return Loss

Input Return Loss

7. S-Parameters files are available for download at macomtech.com.
Evaluation Board

The above thru line can be provided to de-embed the losses of the evaluation board.

Schematic

V_{BIAS} and V_D are separate connections on the evaluation board to give the option of varying I_d without changing R_4. They can be connected together to a single voltage supply during the measurement and in the final layout implementation of the PCB. If two different voltage supplies are used then apply V_D first and then V_{BIAS} to turn on the LNA. To turn off the LNA disconnect V_{BIAS} first and then V_D. R_3 is varied to obtain different levels of gain. R_4 is varied to change the drain current I_d.

Optional Schematic

Optional schematic illustrates alternate grounding choice for C_13 through pin 5. Pin 5 is grounded internally in the package. Electrical performance of both layout methods is identical.

Off-Chip Component Values

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>C_1</td>
<td>3.3 pF</td>
<td>0402</td>
</tr>
<tr>
<td>C_7, C_8, C_10</td>
<td>1000 pF</td>
<td>0402</td>
</tr>
<tr>
<td>C_12, C_13</td>
<td>100 pF</td>
<td>0402</td>
</tr>
<tr>
<td>C_14</td>
<td>100 µF</td>
<td>Tantalum, Size D</td>
</tr>
<tr>
<td>L_1</td>
<td>9 nH</td>
<td>0402</td>
</tr>
<tr>
<td>L_2</td>
<td>15 nH</td>
<td>0402</td>
</tr>
<tr>
<td>R_3</td>
<td>150 Ω</td>
<td>0402</td>
</tr>
<tr>
<td>R_4</td>
<td>240 Ω</td>
<td>0402</td>
</tr>
</tbody>
</table>
Lead-Free 2 mm 8-Lead PDFN†

† Reference Application Note S2083 for lead-free solder reflow recommendations. Meets JEDEC moisture sensitivity level 1 requirements.
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